REMARKS

Claim Amendments

The amendments to claims 5, 8, 12 and 16 concerning "a peak temperature of the surface temperature of the steel product" are supported by the following terminology on page 21, lines 3 to 7 of the specification: "the surface temperature is controlled so that its peak value does not exceed the Curie point and the Ac_1 transformation point."

Prior Art Rejection

Claims 5 to 17 and 22 to 29 were rejected under 35 USC 103 as being obvious over Hino et al. (EP 1359230 or WO 02/050317) (see the top of page 2 of the September 17, 2009 Advisory Action).

Differences Between Applicants' Claims 5, 8, 12 and 16 and Hino et al. (EP 1359230)

Hino et al. (EP 1359230) is based on an application which was previously filed by some of the applicants of the present application. Applicants' claims 5, 8, 12 and 16 represent an improvement over Hino et al.

Hino et al. relate to a method of manufacturing a steel plate, wherein a steel plate is discontinuously heated in two or

more cycles to a target temperature, and wherein the steel plate passes through a plurality of induction heating apparatuses for intermittent heating, while avoiding overheating of the surface of the steel plate.

Hino et al. differ from applicants' claims 5, 8, 12 and 16 as follows:

In the equation (1) in Hino et al., no consideration is given to the surface temperature of a steel plate.

With a solenoid induction heating apparatus, mainly the surface of a steel plate is heated by the skin effect of the induced electric current wherein the inside of the steel plate is heated by the thermal conduction heat from the surface of the steel plate. This operation makes it difficult to put into practice the heating of the steel plate to a target temperature. The foregoing feature is not expressed in equation (1) in Hino et al.

Submitted herewith is a DECLARATION UNDER 37 CFR 1.132 of Yoshitsugu IIJIMA dated November 12, 2009 (hereinafter referred to as the November 12, 2009 IIJIMA DECLARATION), which sets forth the following simulation model as a comparison between applicants' claims 5, 8, 12 and 16 and Hino et al.

The model of the calculation was performed by solving a difference formula of a heat conduction equation. The model was made wherein heating of mainly a steel product surface was performed by an induced electric current during induction heating, by the skin effect. The changes of temperature exhibited the temperature changes at the end portion of a steel plate surface, the center portion in the plate thickness direction and the average temperature.

The following were the conditions of the simulation model.

(1) Temperature when starting heating: 300°C; target temperature of heating: 650°C.

(2) Length of one unit of induction heating apparatus: 0.86 m; interval of the furnaces: 2.64 m; size of the steel plate: thickness: 40 mm, width: 3,000 mm, and length: 20 m.

(3) The above-mentioned steel plate passed three times through 3 units of induction heating apparatuses. The steel plate ran backwards at the second run.

(4) For every speed at the three passes, the same value was used respectively in the methods of Hino et al. and the presently claimed invention.

Figs. B-1 to B-3 attached to the November 12, 2009 IIJIMA DECLARATION show the results for the examples of the simulation

model according to Hino et al.

The method of Hino et al. concerns preventing the overheating of the steel plate surface, which is performed by initiating the heating after the steel plate surface temperature has reached the average temperature or less but, because the surface temperature of a steel plate is not considered according to the equation (1) of Hino et al., the result of the simulation model showed that the temperature exceeded the upper limit temperature (750°C and Ac_1 transformation point, in the simulation model).

In other words, Hino et al., at the time when the average surface temperature of the steel plate is decreased to the steel plate average temperature or lower, the travel speed of steel plate is determined through calculation, on the basis of the rolling pitch, by the equation (1) of Hino et al. and therefore, once a heating initiation temperature and a target temperature are determined, the electric power is obtained from the equation (1) of Hino et al.

Moreover, it is necessary every time before heating that the steel plate surface temperature is measured without fail to calculate the travel speed and the electric power. In the case of the simulation model, because of three times of passing through

the induction heating apparatus, the travel speed and the electric power were calculated three times before heating.

That is to say, according to the method disclosed by Hino et al., heating is resumed when the steel plate surface temperature has reached the average temperature or less of the steel plate and according to the heating condition by Hino et al., the travel speed of the steel plate, calculated from the equation (1) of Hino et al., is determined from the rolling pitch and therefore, once a heating initiation temperature and a target temperature are determined, the electric power is obtained unambiguously from the equation (1) of Hino et al. Nevertheless, Hino et al. do not teach or suggest a peak value of the steel plate surface temperature in the middle of heating. Hino et al. teach only preventing overheating at the steel plate surface which is performed by means of initiating heating at the time when the steel plate surface temperature has reached the average temperature or less of the steel plate.

The results for applicants' claims 5, 8, 12 and 16 are shown in Figs. A-1 to A-3 attached to the November 12, 2009 IIJIMA DECLARATION. In contrast to Hino et al., Figs. A-1 to A-3 show that "the peak value of the surface temperature of the steel plate is always controlled, even during heat treatment so that

the temperature does not exceed the maximum value of the predetermined temperature range."

Namely, according to applicants' claims 5, 8, 12 and 16, a preset value of electric power is determined by the steps as specified in applicants' claims 5, 8, 12 and 16, wherein a travel speed and the electric power at the first passing is obtained, a travel speed and the electric power are obtained every time at the second passing, third passing... and the nth passing, and therefrom, there are selected passing times which satisfy a condition that surface temperatures of the steel plate and temperatures in the center portion in the plate thickness direction, or temperatures at predetermined positions in the plate thickness direction are within the desired temperature range, while the time of heating is the shortest or the heating is finished within a predetermined time (namely, an optimized treatment).

Therefore, according to applicants' claims 5, 8, 12 and 16, the peak value of the surface temperature of the steel plate never exceeds the upper limit temperature at all times, even in the middle of heating.

In fact, as shown in the aforesaid Figs. A-1 to A-3 and B-1 to B-3, in comparison of the methods according to applicants'

claims 5, 8, 12 and 16 and Hino et al., although the travel speeds of the steel plate are identical, the preset values applied to the second passing time and thereafter are different. In particular, according to applicants' claims 5, 8, 12 and 16, the values for the electric power of the third passing time and thereafter are substantially lowered, when compared with the electric power values of Hino et al.

For the reasons discussed above, applicants' claims 5, 8, 12 and 16 serve to avoid problems which arise at the time of the actual heating treatment of the steel plate, which problems cannot be overcome by Hino et al.

Hino et al., on pages 3 to 4 in paragraph Nos. [0020] to [0022], disclose a method for determining the amount of electric power to an induction heating unit according to the following equation (1) when the necessary temperature increased is provided, so as to rapidly carry out tempering at or shorter than the rolling pitch:

$$P \geqq (1/\eta)\cdot\rho\cdot H\cdot W\cdot L\cdot Cp\cdot(\Delta T/\Delta t)\cdot[(Lc+Lw)/Lc]\cdot[1/(N\cdot M)] \ldots\ldots\ldots\ldots (1)$$

, wherein P: whole electric power, η: heating efficiency, ρ: density, H: plate thickness, W: plate width, L: plate length, Cp: specific heat, ΔT: temperature increase, Δt: rolling pitch, Lc: coil length, Lw: distance between induction heating units, N: number of induction heating units, and M: number of times of heating.

Nevertheless, the above-mentioned equation (1) was formulated to be used at the time of designing heat treatment equipment using induction heating apparatuses for determining the number of induction heating apparatuses and their electric power capacity when the magnitude of the temperature increase is given. This is different from the methods of applicants' present claims 5, 8, 12 and 16, which are to be used in actual heating operations.

The preceding paragraph is explained in detail as follows:

1. <u>There is no description of the traveling speed in the Equation (1) of Hino et al.</u>

Electric power for heating should be determined in proportion to the traveling speed of a steel plate. Nonetheless, this is not expressed in the equation (1) of Hino et al., although the rolling pitch is indicated as a parameter. In contrast thereto, if the traveling speed at every heating time is changed in applicants' present claims 5, 8, 12 and 16, heating can be performed in a shorter time with a smaller electric power supply. This is not possible in the equation (1) of Hino et al., because the traveling speed at every heating time is not obtained.

On the other hand, as shown in applicants' Table 1 on page 17 of the corrected translation filed on September 1, 2009 with

Examples of the size of steel plates and the traveling speed, according to applicants' claims 5, 8, 12 and 16, the traveling speeds are altered at every heating time. Applicants' Table 1 is reproduced as follows:

TABLE 1

WIDTH (mm)	1000				2000				3000			
THICKNESS (mm)	NUMBER OF TIMES OF PASSAGE	SPEED 1	SPEED 2	SPEED 3	NUMBER OF TIMES OF PASSAGE	SPEED 1	SPEED 2	SPEED 3	NUMBER OF TIMES OF PASSAGE	SPEED 1	SPEED 2	SPEED 3
10	1		60		1		40		1		20	
20	1		40		1		20		3	30	40	40
30	1		20		3	30	40	40	3	20	30	30

SPEED 1,2 and 3: transfer speed(m/min)

2. <u>Hino et al. Do Not Disclose a Parameter Temperature in Their Equation (1)</u>

With a solenoid type induction heating apparatus, the steel plate surface is heated by the skin effect of the induced electric current. This is a hindrance to the implementation of heat treatment for heating a steel plate up to a target temperature by using induction heating apparatuses.

This fact is not expressed in the equation (1) of Hino et al.

3. <u>In Equation (1) of Hino et al., Both the Shortest Heating Time and the Minimum Consumption Rate of Electric Power Are Not Expressed</u>

The amount of heat dissipated in the air differs by the temperature of a steel plate. Therefore, the electric power for

heating and traveling speeds vary by the temperature of the steel plate, even when the magnitude of the temperature increase is the same. In view of this, the combination of the amount of electric power, the number of heating times of passage, and the traveling speed differ between the cases of a minimum heating time and a minimum consumption rate of electric power. This phenomenon is not taken into account in the equation (1) of Hino et al.

On the other hand, with applicants' present claims 5, 8, 12 and 16, the relationships among the amount of electric power, the number of times of passage and the traveling speed are taken into account. As examples, there are shown in applicants' Fig. 4, the number of times of passage with priority in treatment time, while the number of times of passage with priority in electric power consumption rate is depicted in applicants' Fig. 5.

For example, as set forth in the present specification from page 18 at line 19 to page 23 at line 16, under the heading "Sixth embodiment" and in applicants' Fig. 3A to Fig. 3C and Figs. 4 and 5, it is understood from the results therein that the length of the heat treatment time can be shortened and the electric power consumption can be reduced when heating is performed by passing 3 times through 3 units of induction heating apparatuses, while controlling the speed at every time of passage

rather than passing 1 time through 6 units of induction heating apparatuses or passing 1 time through 3 units of induction heating apparatuses. Moreover, when the number of units of induction heating apparatuses is reduced, the amount of capital investment is reduced.

In applicants' Fig. 4 and Fig. 5, there is shown an advantageous number of times of passage in terms of time and the amount of electric power supply depending on the thickness of the steel sheet, the length of the heating time and the target of the heating. When the thickness of a steel plate is large, the length of treatment time is reduced by passing the plate a plurality of times. However, there are cases when heating one time is advantageous if the thickness of a steel plate is small.

As discussed above, applicants' present claims 5, 8, 12 and 16 provide a method of determining what passing time is most appropriate by selecting the length of the heating time and the electric power to be consumed, after obtaining the speed and the electric power supply at every number of times of passage. This is not taught or suggested by Hino et al.

Further, Hino et al. do not teach or suggest the "Third embodiment" set forth from page 11 at line 11 to page 17 at line

17 in applicants' specification, wherein the necessary conditions of applicants' present claims 5, 8, 12 and 16 are set forth (see page 31, line 6 to page 37, line 12 of applicants' specification) and applicants' Figs. 11 to 13. Methods are described therein for (i) heating a steel plate in the shortest period of time; (ii) heating a steel plate, within a targeted time or (iii) heating a steel plate while reducing the electric power consumption to a minimum.

Applicants' claims 5, 8, 12 and 16 provide an improvement over Hino et al. in that simultaneously a high productivity and a reduction of electric power consumption are realized by applicants' claimed methods.

For the reasons discussed above, applicants' present claims 5, 8, 12 and 16 solve the problems occurring at the time of actually conducting heating of a steel plate, which cannot be accomplished by Hino et al.

Applicants' present claims provide methods of determining speed and electric power at every passage and selecting the most suitable passing time based on the heat treatment time and electric power consumption. Such methods are not taught or suggested by Hino et al.

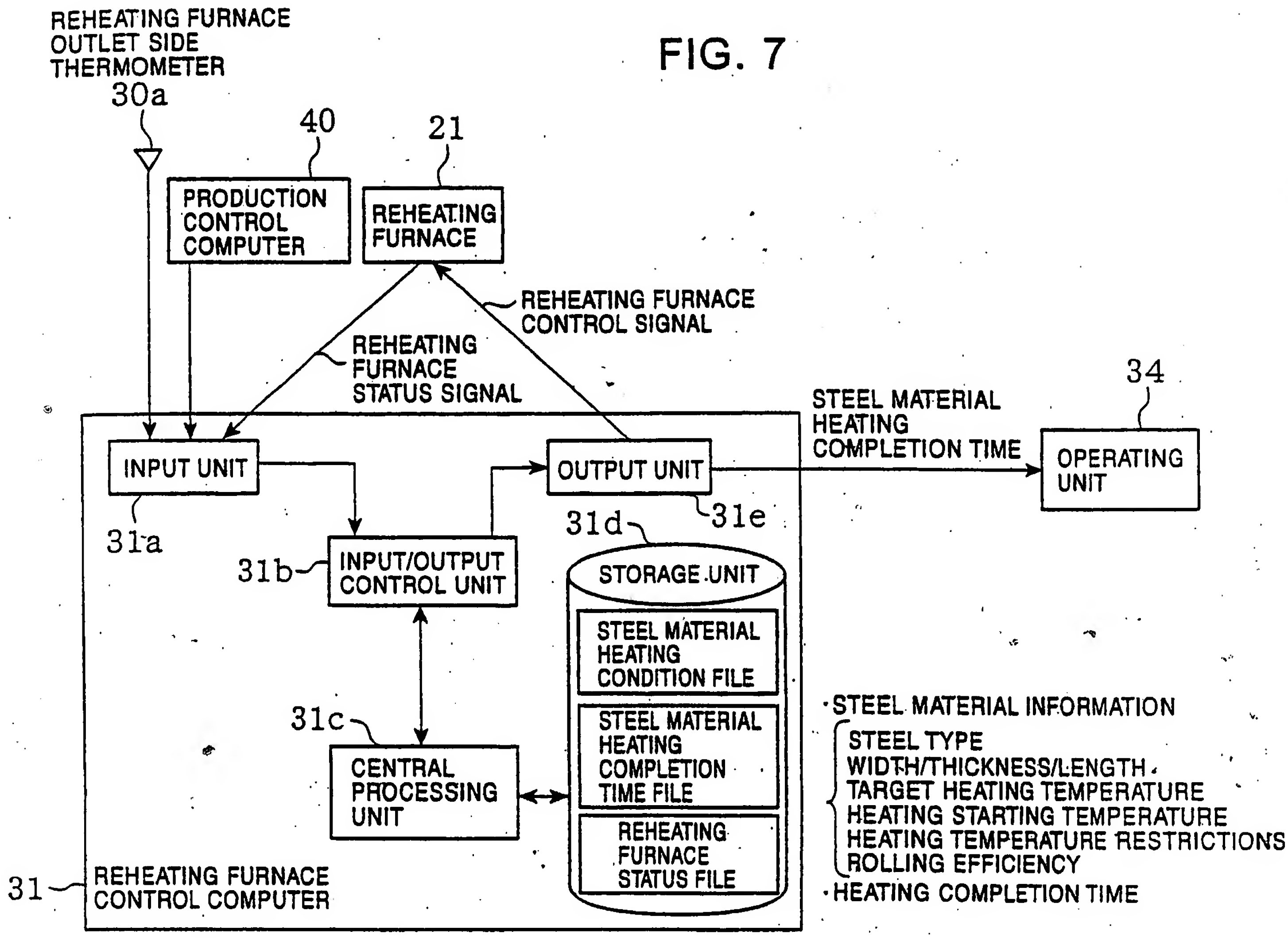
Further differences between applicants' present claims 5, 8, 12 and Hino et al. are as follows:

Input and Output

The input parameter and output parameter for processing according to applicants' claims 5, 8, 12 and 16 and according to Hino et al. are discussed hereinbelow.

In applicants' claims 5, 8, 12 and 16, the electric power, the number of times of passage and the transfer speeds are calculated from the sizes of the steel materials, the heating temperatures and the maximum temperatures (see Fig. 7 in the present application, which is reproduced hereinbelow, and Fig. A provided hereinbelow).

FIG. 7



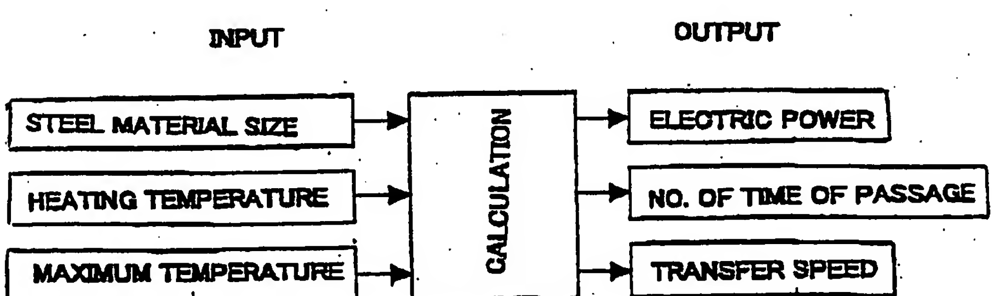


Fig. A INPUT / OUTPUT BY CLAIMS 5, 8, 12 AND 16 OF PRESENTLY CLAIMED INVENTION

In Hino et al., the electric power (P) is calculated from the sizes (H, W and L) of the steel materials, the heating temperatures (ΔT), the maximum temperature, the number of times of passage (M) and the transfer speeds (the rolling pitch Δt of the steel plates) (see the Equation (1) on page 4, lines 1 to 4 of Hino et al. and Fig. B provided hereinbelow).

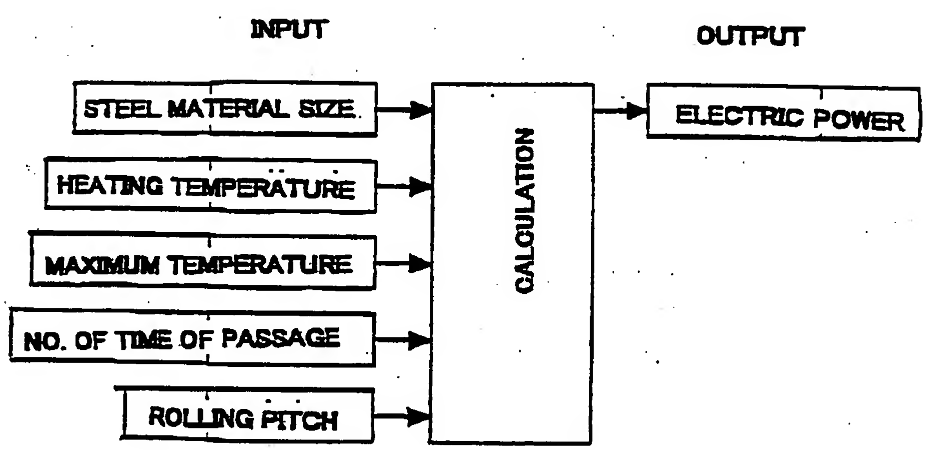


Fig. B INPUT / OUTPUT OF HINO ET AL.

The above-mentioned differences between the methods according to applicants's claims 5, 8, 12 and 16 and according to Hino et al. are evidenced by the following additional two types of processing treatments that are necessary to be carried out to practically conduct heat treatments according to Hino et al:

(a) Processing through trial and error for obtaining the number of times of passage and the transfer speeds during heating (see paragraph nos. [0020] to [0022] on pages 3 to 4 of Hino et al.).

(b) Measuring the surface temperature and suspending the same when the surface temperature is likely to exceed the upper limit (see claim 2 on page 7 of Hino et al. and lines 1 to 3 in paragraph no. [0016] on page 3 of Hino et al.).

Flow of Processing

The differences in the flow of the processing when practically conducting heating between Hino et al. and the presently claimed invention are seen in the following Fig. C:

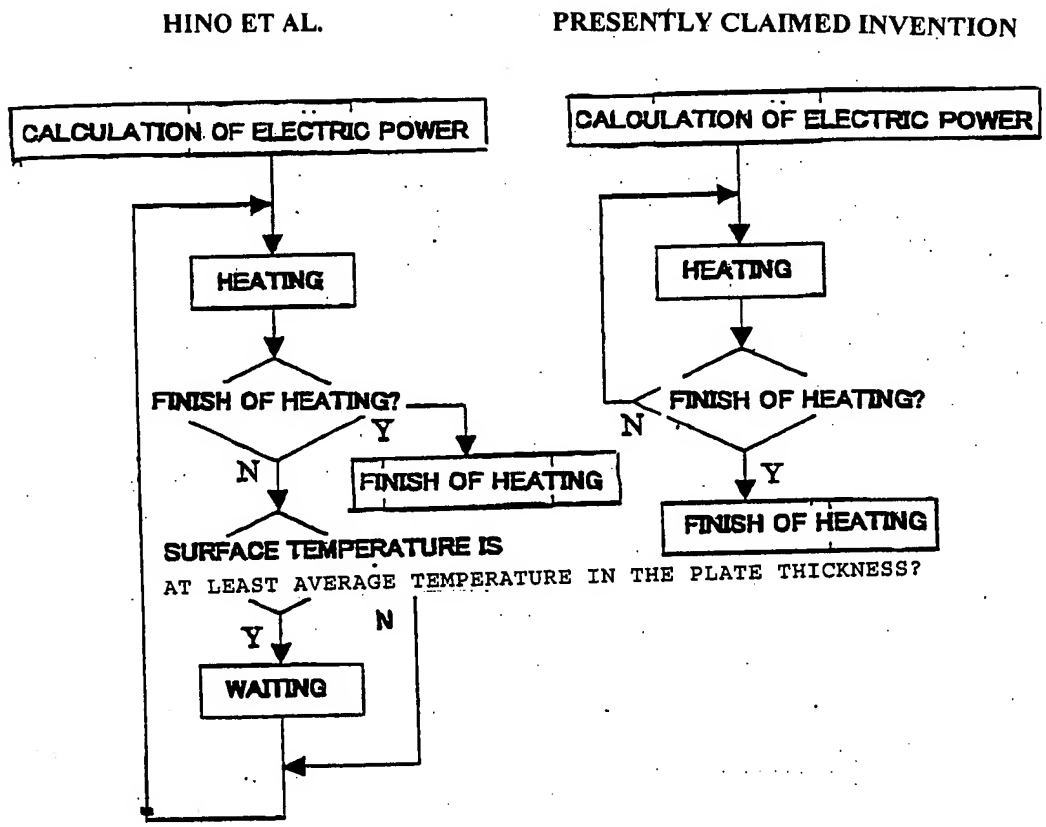


FIG. C DIFFERENCES OF PROCESS FLOWS BETWEEN APPLICANTS' CLAIMS 5, 8, 12 AND 16 (right diagram) AND HINO ET AL. (left diagram)

Movements of the Steel Material

The differences in the movements of the steel material between the presently claimed invention and Hino et al. are depicted in the following Fig. D.

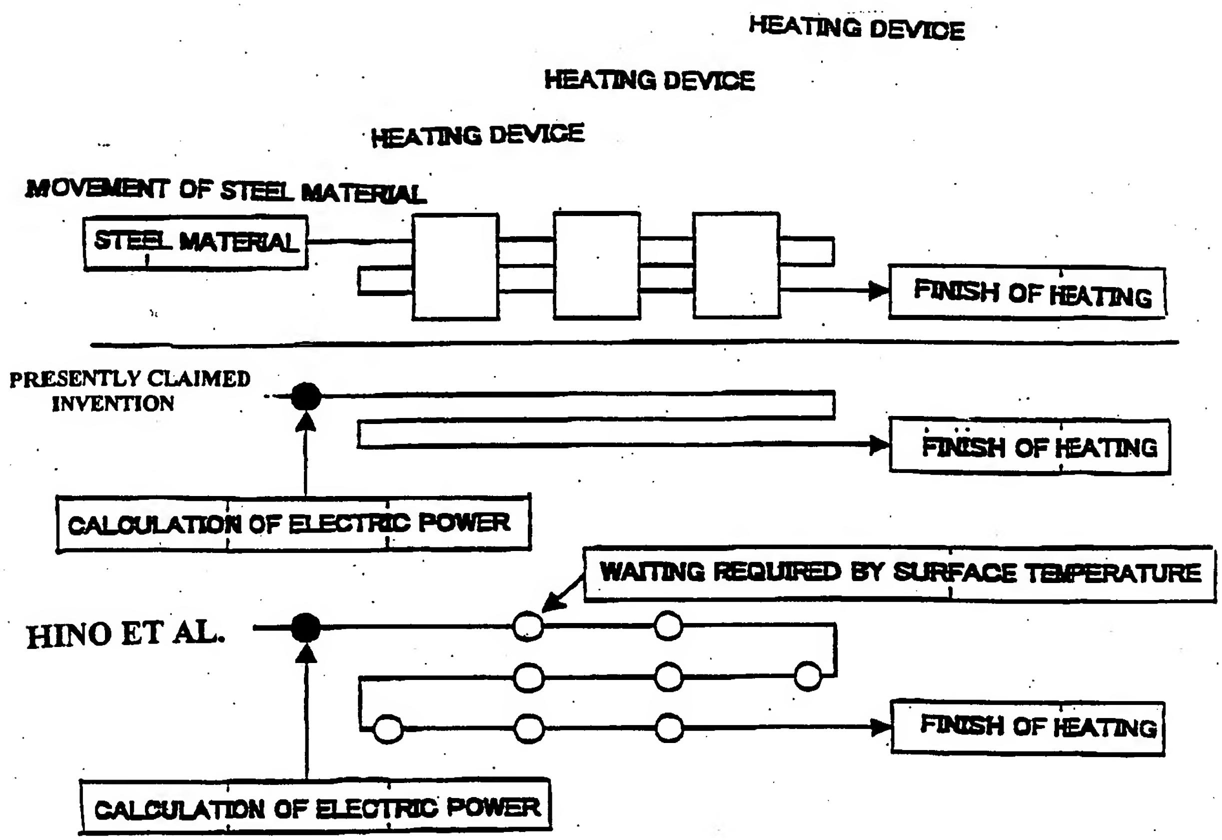


FIG. D DIFFERENCES OF MOVEMENTS OF STEEL MATERIALS BETWEEN APPLICANTS' CLAIMS 5, 8, 12 AND 16 (upper diagram) AND HINO ET AL. (lower diagram)

In Hino et al., the electric power is calculated before heating and, after heating, the temperature is measured and the heating is restarted. At this stage, when the surface temperature is high, it is necessary to wait until the surface temperature reaches or is lower than the mean temperature in the thickness direction of the steel plate.

In applicants' claims 5, 8, 12 and 16, before heating, the electric power, the number of times of passage and the transfer speeds are calculated and subsequently, heating is conducted. Because the electric power, the number of times of passage and the transfer speeds are determined in consideration of the surface temperatures according to the presently claimed invention, it is not necessary to measure the surface temperature at every heating time and wait until the surface temperature is decreased, which results in a lowering of efficiency, as is the case in Hino et al.

As recited in claim 2 of Hino et al and disclosed in the description set forth in lines 1 to 3 in paragraph no. [0016] on page 3 of Hino et al., heating is initiated at the time when the surface temperature, before the subsequent heating, reaches a temperature which is equal or under the average temperature in the plate thickness direction of the steel plate, thereby the

surface temperature of the steel plate is controlled not to exceed a predetermined temperature. Therefore in Hino et al., the surface temperature of the steel plate is measured each time before passing through an induction heating furnace for heating, and when the surface temperature is high. It is thus required in Hino et al. to wait until the surface temperature of the steel plate drops to at least a temperature which is an average temperature in the plate thickness direction.

In contrast to Hino et al., in the case of applicants' claims 5, 8, 12 and 16, as set forth in steps (a) to (d), before the steel plate passes through the induction heating furnace for heating, there are calculated the transfer speeds, the electric power, the number of times of passage and the number of units of the induction heating furnace for passing the steel plate for each of the number of times of heating from one time heating, two times or more of heating and N times of heating, under the condition that the surface temperature of the steel plate and the temperature of the inner portion of the steel plate are in a predetermined temperature range beforehand. As a result of the calculations, the number of heating times having the shortest heating time or the number of heating times having the smallest electricity consumption costs is selectively determined.

Applicants' claims 5, 8, 12 and 16 thus result in the following advantages: (i) heating does not have to be suspended in the middle of the heating, as is the case in Hino et al.; (ii) the length of the heating time can be reduced and (iii) the loss of electricity (energy) caused by radiational cooling, which is brought about by the suspended heating of the steel plate in Hino et al., can be avoided.

It is respectfully submitted that the aforesaid advantageous results afforded by the presently claimed invention are not provided by Hino et al., wherein the method of determining the heating conditions is substantially different than in the presently claimed invention.

It is therefore respectfully submitted that the presently claimed invention patentably distinguishes over Hino et al.

Withdrawal of the 35 USC 103 rejection is thus respectfully requested.

Reconsideration is requested. Allowance is solicited.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned at the number given below for prompt action.

Respectfully submitted,

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Enc.: DECLARATION UNDER 37 CFR 1.132 of Yoshitsugu IIJIMA
(including Figs. A-1, A-2, A-3, B-1, B-2 and B-3)